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MONTHLY WEIGHT AND BALANCE REPORT FOR THE APOLLO SPACECRAFT CONTRACT NAS 9-150

[U]

1 APRIL 1963

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Prepared by

Weight Control

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INTRODUCTION

The April Report reflects a spacecraft weight increase of 1065 pounds at injection and 10 pounds at Service Module burnout. The weight increase at injection is due primarily to the adoption of 313 second specific impulse for calculating the Service Module propellant loading. This value is based upon subtracting 3 standard deviations from the mean value indicated by early engine tests.

The major change in the Command Module was due to the deletion of one drogue disconnect and a decrease in the sequence control. The controls and displays were completely revised to reflect the current design, which makes available more space and changes the type of switches from push button to toggle. The Command Module summary page has been revised to separate the ablator status from the balance of the structure.

The major changes in the Service Module were in the electrical fuel cell hydrogen system and in the support structure for the oxygen tank. There have been some additions to the potential weight changes reflecting possible savings in the supercritical gas storage system.

The Launch Escape System weight decrease was due to the deletion of the flow separator. The savings was partially offset due to the resulting requirement for additional ballast to maintain the present combined Command Module - LES center of gravity. The reference dimensional diagram has been changed to reflect the deletion of the flow separator.

The current injected weight of 83275 pounds is based on the Service Module loaded with sufficient propellant at a specific impulse of 313.0 to provide 10 per cent ΔV margin. This is also based on a LEM weight, including crew, of 25000 pounds.

The earth orbital mission weight summary reflects a two stage booster to orbit injection without the use of Service Module propulsion and is based on a complete Service Module loaded with 2465 pounds of propellant.

In several places throughout this report, weight has been transferred from one functional area to another. This has been done to integrate supports into the structure functional area. There are no total weight changes resulting from items being transferred from one group to another.

APOLLO LOR MISSION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT^2)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	8960	1043.7	0.6	8.3	4181	3594	3592
SERVICE MODULE - Less Propellant	9820	911.1	0.7	-0.6	6514	10426	10300
TOTAL - Less Propellant	18780	974.3	0.6	3.6	10775	31881	31672
PROPELLANT - S/M**	36925	905.5	6.0	-2.6	19200	19900	25900
TOTAL - With Propellant	55705	928.7	4.1	-0.4	30157	64628	70391
LUNAR EXCURSION MODULE	24460	623.0	0.0	0.0	13616	12776	13247
ADAPTER - LEM - C-5	3110	640.1	0.0	0.0	6991	8599	8599
TOTAL - Injected	83275	828.1	2.8	-0.3	50835	453595	459898
LAUNCH ESCAPE SYSTEM	6330	1296.5	0.0	0.0	206	7717	7717
TOTAL - Spacecraft Launch	89605	861.2	2.6	-0.3	51051	739849	746161

NOTES: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

**The propellant weight of 36925 pounds provides approximately 10% $\triangle$ V margin, and excludes 210 pounds of $\triangle$ V propellants tanked in the service module reaction control system. The propellant weight is based on a specific impulse of 313.0.

APOLLO EARTH ORBIT MISSION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT^2)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	8960	1043.7	0.6	8.3	4181	3594	3592
SERVICE MODULE - Less Propellant	9820	911.1	0.7	-0.6	6514	10426	10300
TOTAL - Less Propellant	18780	974.3	0.6	3.6	10775	31881	31672
PROPELLANT - S/M**	2465	849.1	27.0	-11.7	900	500	650
TOTAL - With Propellant	21245	959.8	3.7	1.8	12112	39872	40028
ADAPTER - C-1	630	779.8	0.0	0.0	545	599	599
TOTAL - Injected	21875	954.6	3.6	1.8	12660	44751	44909
LAUNCH ESCAPE SYSTEM	6330	1296.5	0.0	0.0	206	7717	7717
TOTAL - Spacecraft Launch	28205	1031.3	2.7	1.4	12883	176308	176475

NOTES: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line

**The earth orbital weights are based on a complete service module and include 2,465 pounds of propellant for an orbital altitude of about 129 nautical miles with a payload launch azimuth of 72°.

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APOLLO LAUNCH ABORT CONFIGURATION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT^2)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	8960	1043.7	0.6	8.3	4181	3594	3592
LAUNCH ESCAPE SYSTEM	6330	1296.5	0.0	0.0	206	7717	7717
TOTAL - Launch Abort	15290	1148.3	0.3	4.8	4442	62534	62477
LESS - MAIN AND PITCH MOTOR PROPELLANTS	-3210	1296.5	0.0	0.0	-69	-1330	-1330
TOTAL - LES Burnout	12080	1108.9	0.4	6.1	4352	41930	41893

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

COMMAND MODULE

WEIGHT AND CENTER OF GRAVITY SUMMARY

VEHICLE CONFIGURATION	LAUNCH ABORT CONDITION				ENTRY CONDITION (LUNAR MISSION)			
	WEIGHT	X	Y	Z	WEIGHT	X	Y	Z
Earth Launch	8960	1043.7	0.6	8.3	8960	1043.7	0.6	8.3
Add: Unexpended Waste & Water	-	-	-	-	66			
Shift Crew to Entry Position	-	-	-	-				
Prior to Entry	-	-	-	-	9026	1043.8	-0.1	10.3
Less: Propellant, RCS	-	-	-	-	-258	1022.6	-6.2	56.6
Ablation Material Burnoff	-	-	-	-	-265	1019.7	0.0	11.2
Nose Cone & Discone Antenna	-391*	1099.8	-0.1	2.1	-365	1100.1	-0.1	1.6
Drogue Chute	-25	1090.0	11.0	-22.0	-25	1090.0	11.0	-22.0
Entry Cooling Water	-	-	-	-	-6	1022.5	-26.1	61.8
Prior to Main Chute Deployment	8544	1041.0	0.6	8.7	8107	1042.6	0.1	9.3
Less: Main Parachutes (3)	-440	1089.9	0.3	6.7	-440	1089.9	0.3	6.7
Shift Crew to Landing Position								
Landing	8104	1038.3	0.6	8.9	7667	1039.9	0.1	8.2

*Represents nose cone with ablative material intact (no burnoff).

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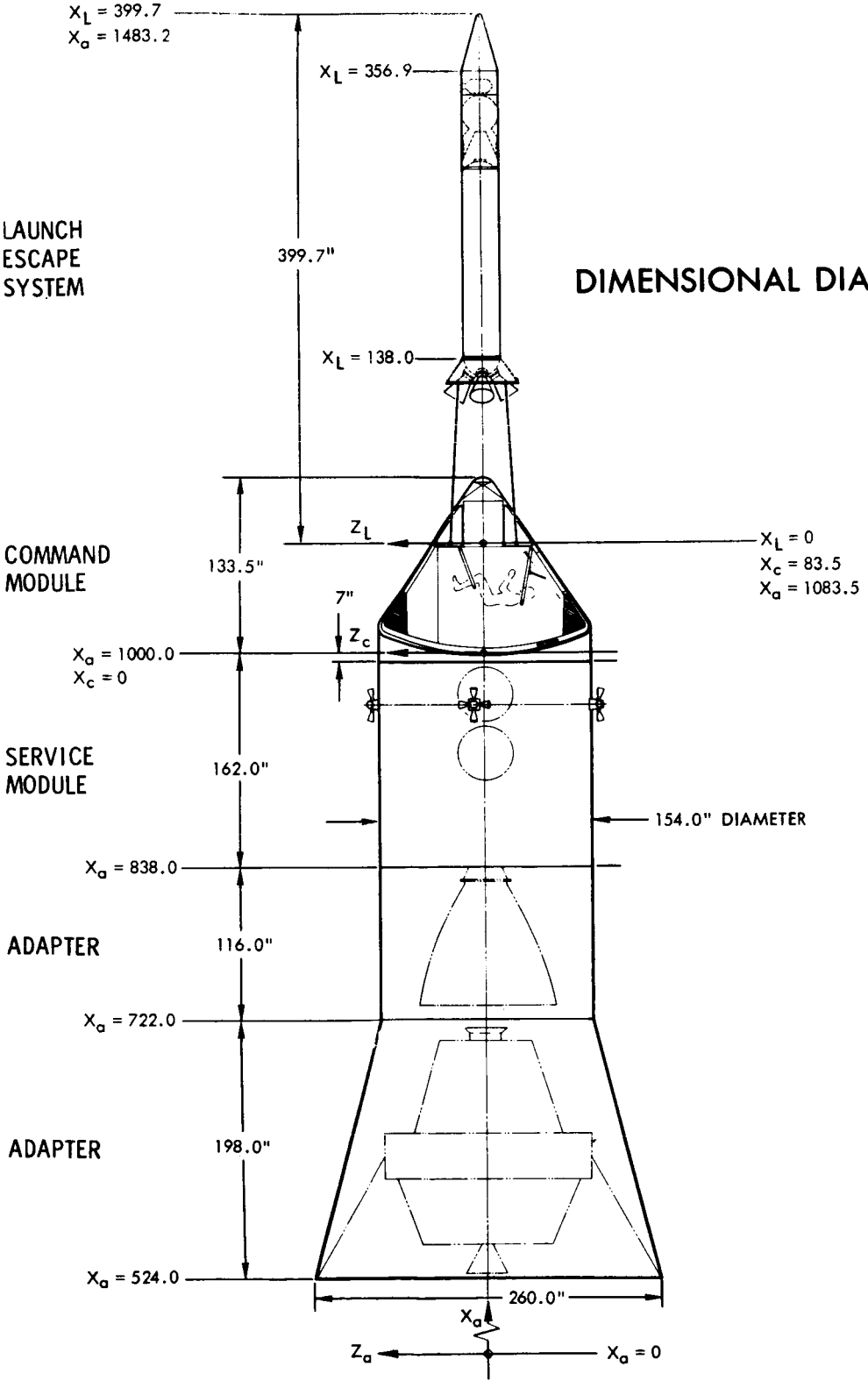
DIMENSIONAL DIAGRAM



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SPACECRAFT

WEIGHT STATUS SUMMARY

ITEM	PREVIOUS STATUS 3-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 4-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
COMMAND MODULE	8990	-30	8960	60	38	2
SERVICE MODULE*	54780	+40	54820	7	93	
LES	6400	-70	6330	41	59	
ADAPTER	3110		3110	100		
TOTAL	73280	-60	73220	20	80	

NOTE: *Maximum capacity usable propellant of 45000 pounds included in status.

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COMMAND MODULE WEIGHT STATUS

ITEM	PREVIOUS STATUS 3-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 4-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
Structure	(3982)	(+191)	(4173)			
Structure - Less Ablator	2722	+191	2913	36	64	
Ablation Material	1260		1260	100		
Crew Systems	512		512	100		
Communication and Instrumentation	889	-92	797	100		
Guidance and Navigation	404	+2	406	100		
Stabilization and Control	233	-39	194	100		
Reaction Control	294	-25	269	84	16	
Electrical Power	430	-49	381	100		
Environmental Control	272	-7	265	30	70	
Earth Landing	563	-17	546	11	64	25
WEIGHT EMPTY	7579	-36	7543	66	32	2
Crew (3) (50, 70, 90 Percentile)	528		528		100	
Suits and Personal Equipment	134		134	100		
Food and Containers	90		90	100		
Reaction Control Propellant	258		258		100	
Environmental Control Chemicals	151	+6	157		100	
Scientific Payload	250		250	100		
GROSS WEIGHT	8990	-30	8960	60	38	2

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COMMAND MODULE

CURRENT WEIGHT EMPTY CHANGES

STRUCTURE		(+191.0)
Transfer secondary support structure from crew compartment heat shield to secondary structure.		-25.0
Transfer secondary support structure from functional areas to secondary structure as follows:		+216.0
Crew Compartment Heat Shield	+25.0	
Reaction Control System	+25.0	
Communication and Instrumentation	+89.4	
Stabilization and Control	+39.0	
Electrical Power	+37.4	
Miscellaneous	+ .2	
COMMUNICATION AND INSTRUMENTATION		(-92.0)
Increase C-Band transponder to agree with design established by subcontractor.		+4.3
Increase multiplexer to incorporate filter formerly included in VHF recovery antenna and transmission.		+1.0
Decrease telemetry equipment to agree with redesign per subcontractor.		-11.0
Increase signal conditioner due to change in number of signals to be conditioned from 44 to 124.		+13.2
Increase audio center due to subcontractor revised estimate.		+3.0
Decrease antenna and transmission line per revised estimates.		-5.5
Transfer installation support provisions and environmental support provisions to secondary structure.		-89.4
Decrease controls and displays based on estimate of layouts reflecting revised design.		-7.6
GUIDANCE AND NAVIGATION		(+2.0)
Decrease NAA cabling per revised estimate.		-0.6
Decrease inertial platform per latest MIT Status Report.		-0.4
Increase navigation base per latest MIT Status Report.		+3.0

[redacted]

COMMAND MODULE

CURRENT WEIGHT EMPTY CHANGES

STABILIZATION AND CONTROL		(-39.0)
Transfer supports and environmental coldplate provisions to secondary structure.		-39.0
REACTION CONTROL SYSTEM		(-25.0)
Transfer supports to secondary structure.		-25.0
ELECTRICAL POWER SYSTEM		(-49.0)
Transfer battery coldplates to secondary structure.		-6.0
Transfer inverter coldplates to secondary structure.		-9.4
Transfer installation provisions to secondary structure.		-22.0
Delete umbilical feed through plate as it is included in structure.		-11.6
ENVIRONMENTAL CONTROL SYSTEM		(-7.0)
Increase regenerative heat exchanger based on Airesearch status.		+0.7
Decrease glycol reservoir based on Airesearch Status Report.		-0.3
Increase cabin heat exchanger based on Airesearch Status Report.		+0.1
Decrease water supply system subcontractor components due to:		-0.5
Decrease of potable water tank capacity from 54 to 36 pounds, consistent with current requirements.	-3.2	
Addition of 10 pound capacity freon tank in lieu of using waste water tank as storage.	+1.7	
Deletion of one water check valve and reduction of waste water tank due to simplification of system.	-0.5	
Addition of 2.5 pound capacity hot water tank and associated heater required for food reconstitution.	+1.5	
Decrease subcontractor common brackets and plumbing as the heat exchanger ducting is included with the subcontractor pressure suit circuit and subcontractor pressure and temperature control.		-6.6
Decrease supports based on revised estimates.		-0.4

[redacted]

COMMAND MODULE

CURRENT WEIGHT EMPTY CHANGES

EARTH LANDING SYSTEM	(-17.0)
Delete one of two drogue disconnect installations consistent with present requirements.	-7.4
Decrease sequence control unit due to redesign and deletion of the inertia switch on the manned vehicles.	-9.8
Increase electrical pyrotechnic provisions based on revised estimate.	+0.2
TOTAL COMMAND MODULE CURRENT WEIGHT EMPTY CHANGES	-36.0

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COMMAND MODULE

CURRENT USEFUL LOAD CHANGES

Increase earth orbit cooling water based on revised estimate.	+1.0
Increase water in potable tank to meet mission cooling requirements plus post landing potable water requirements of 36 pounds.	+5.0
TOTAL COMMAND MODULE CURRENT USEFUL LOAD CHANGES	+6.0

SERVICE MODULE WEIGHT STATUS

ITEM	PREVIOUS STATUS 3-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 4-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
Structure	2491		2491	80	20	
Electronics	151		151	100		
Reaction Control	597	-4	593	79	21	
Electrical Power	1160	+30	1190	25	75	
Environmental Control	78		78	30	70	
Propulsion System	(3062)	(+9)	(3071)			
Engine Installation	640		640	85	15	
Propellant System	2422	+9	2431	14	86	
WEIGHT EMPTY	7539	+35	7574	50	50	
Usable RCS Propellant	790		790		100	
Electrical Power Supercritical Fluids	482	+5	487		100	
Environmental Control Supercritical Fluids	208		208		100	
Main Propulsion Helium	99		99		100	
Main Propellant Residuals	(617)		(617)		100	
Trapped - System	225		225			
Trapped - Engine	67		67			
Mixture Ratio Tolerance	100		100			
Loading Tolerance	225		225			
Unusable RCS Propellant	45		45		100	
BURNOUT WEIGHT	9780	+40	9820	39	61	
Main Propellant (Maximum Usable Capacity)	45000		45000		100	
GROSS WEIGHT	54780	+40	54820	7	93	

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SERVICE MODULE

CURRENT WEIGHT EMPTY CHANGES

REACTION CONTROL SYSTEM		(-4.0)
Decrease engines due to incorporation of actual weights in lieu of estimated weights per Marquardt weight status.		-4.0
ELECTRICAL POWER SYSTEM		(+30.0)
Increase fuel cell hydrogen system subcontractor components due to:		+12.2
Addition of insulation foil to reduce radiation per Beech status.	+8.8	
Addition of temperature sensors to signal conditioner package per Beech status.	+1.0	
Increase of valve module per Beech status.	+5.0	
Increase in fuel cell module valves due to use of solenoid valves in lieu of squib valves.	+4.0	
Deletion of cross feed valves and pressure switch per Beech status.	-2.8	
Deletion of squib valve module per Beech status.	-1.4	
Decrease in skin thickness of lower shell support due to decreased loads.	-2.6	
Decrease in line lengths of probe assembly vent tube per Beech status.	-0.6	
Increase of disconnect valve per Beech status.	+0.8	
Increase fuel cell and ECS oxygen system subcontractor components due to:		+0.6
Addition of insulation foil to reduce radiation per Beech status.	+2.6	
Addition of temperature sensors to signal conditioner package per Beech status.	+1.0	
Increase of valve module per Beech status.	+3.2	

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SERVICE MODULE

CURRENT WEIGHT EMPTY CHANGES

ELECTRICAL POWER SYSTEM (CONTINUED)		
Increase of fuel cell module valves due to use of solenoid valves in lieu of squib valves per Beech status.	+4.6	
Deletion of cross feed valve per Beech status.	-4.8	
Deletion of squib valve module per Beech status.	-1.4	
Increase of disconnect valve per Beech status.	+0.2	
Decrease of line lengths of probe assembly vent and fill tube per Beech status.	-2.4	
Increase of miscellaneous components per Beech status.	+3.6	
Increase of oxygen tank support due to use of cylindrical skirt in lieu of truss design per Beech status.	+11.2	
Deletion of oxygen tank lower skirt from Beech responsibility at NAA direction.	-13.0	
Deletion of oxygen tank upper skirt from Beech responsibility at NAA direction.	-10.8	
Addition of oxygen tank support ring to provide for NAA/SID shelf mount design.	+6.6	
Add NAA/SID shelf mount for oxygen tank support in lieu of Beech skirt supports.		+18.0
Decrease power distribution supports per revised estimate.		-0.8
MAIN PROPULSION		(+9.0)
Increase tank skirts due to the elimination of beads and an increase in gauge of the lower skirts to prevent buckling during launch.		+9.0
TOTAL SERVICE MODULE WEIGHT EMPTY CHANGES		+35.0

[redacted]

SERVICE MODULE

CURRENT USEFUL LOAD CHANGES

Increase weight of the electrical fuel cell reactants resulting from refinement of calculations based on fluid requirements for 506 kw-hr.		+5.0
Hydrogen	+0.5	
Oxygen	+4.5	
TOTAL SERVICE MODULE USEFUL LOAD CHANGES		+5.0

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LAUNCH ESCAPE SYSTEM

WEIGHT STATUS

ITEM	PREVIOUS STATUS 3-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 4-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
Structure	1071	-103	968	8	92	
Electrical System	20		20	100		
Propulsion System						
Main Thrust	4764		4764	50	50	
Jettison	440		440	1	99	
Pitch Control	55		55	75	25	
LES - NO BALLAST	6350	-103	6247	40	60	
BALLAST	50	+33	83	100		
TOTAL L.E.S.	6400	-70	6330	41	59	

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LAUNCH ESCAPE SYSTEM

CURRENT WEIGHT CHANGES

STRUCTURE	(-103)
Delete flow separator from the Launch Escape System. Based on test data, the desired center of pressure versus center of gravity relationship is attainable without this item.	-103
BALLAST	(+33)
Increase ballast weight consistent with combined Command Module and Launch Escape System balance requirements.	+33
TOTAL LAUNCH ESCAPE SYSTEM CURRENT WEIGHT CHANGE	-70

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ADAPTER

WEIGHT STATUS

ITEM	PREVIOUS STATUS 3-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 4-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
Structure	2892		2892			
Electrical	76		76			
Separation System	142		142			
TOTAL ADAPTER	3110		3110	100		

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WEIGHT HISTORY COMMENTS

LAUNCH ESCAPE SYSTEM

The target weight established for the LES is 6,300 pounds, excluding ballast. This weight was based on the September status weight of 6,600 pounds including the necessary ballast to provide currently determined aerodynamic stability to prevent tumbling.

The original target of 5,900 pounds, as reported in the June Status, SID 62-99-5, was based on an attitude controlled configuration. The current configuration weight includes a flow separator, pitch motor and ballast not included in the original target weight.

COMMAND MODULE

The target weight established for the Command Module is 8,500 pounds. An estimated weight breakdown for the target weight is provided for comparative purposes.

The original target weight of 8,340 pounds, as reported in the June Status, SID 62-99-5, did not include the proposed increases nor the Category I reductions presented in the July briefing and incorporated in the July Status Report.

SERVICE MODULE

The target weight established for the Service Module less usable propellant is 11,000 pounds. An estimated weight breakdown for the target weight is provided for comparative purposes. This configuration is sized for 45,000 pounds usable propellant for the 25,000 pound LEM.

The original target weight of 8,675 for the burnout condition was based on a lunar landing configuration sized for 31,000 pounds usable propellant.

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WEIGHT HISTORY

COMMAND MODULE

	ORIGINAL TARGET WT.	TARGET WEIGHT	AUTHORIZED CHANGES	AUTHORIZED WEIGHT 4-1-63
Structure	3670	3720		3720
Crew Systems	565	690	+2	692
Communication & Instrumentation	944	785		785
Guidance & Navigation	310	310	+85	395
Stabilization & Control	175	195		195
Reaction Control	183	195		195
Electrical Power	354	390		390
Environmental Control	228	255		255
Earth Landing	530	610	-106	504
WEIGHT EMPTY	6959	7150	-19	7131
Crew	528	528		528
Suits & Personal Equipment	82	126		126
Survival Water	54	18		18
Food & Containers	90	90		90
Reaction Control Propellant	210	210		210
Environmental Control Fluids	167	128		128
Scientific Payload	250	250		250
GROSS WEIGHT	8340	8500	-19	8481

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COMMAND MODULE WEIGHT HISTORY

WEIGHT EMPTY AUTHORIZED CHANGES

COMMUNICATION & INSTRUMENTATION	(+2)
Add a loudspeaker in the crew compartment per NASA request.	+2
GUIDANCE & NAVIGATION	(+85)
Increase the Guidance and Navigation per recent weight report from M.I.T. Since NAA does not have weight control responsibility for the M.I.T. Design, the weight changes in their Weight and Balance Report will be considered as authorized changes.	+78
EARTH LANDING	(-106)
Remove the impact attenuation system per TWX SM 032, dated 23 July 1960, reported in the 1 November 1962 Weight and Balance Report.	-106
TOTAL COMMAND MODULE WEIGHT EMPTY CHANGES	-19

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WEIGHT HISTORY

SERVICE MODULE

	ORIGINAL TARGET WT.	TARGET WEIGHT	AUTHORIZED CHANGES	AUTHORIZED WEIGHT 4-1-63
Structure	2810	3203		3203
Electronics	216	145		145
Reaction Control	254	737		737
Electrical Power	1076	1203		1203
Environmental Control	413	250		250
Propulsion System				
Engine Installation	375	606		606
Propellant System	1928	2456		2456
WEIGHT EMPTY	7072	8600		8600
Usable RCS Propellant	400	611		611
Usable Fuel Cell Reactants	380	479		479
Environmental Control Fluids	288	193		193
Main Propulsion Helium	97	139		139
Main Prop. Residuals	300	900		900
Unusable RCS Propellant	20	61		61
Unusable Fuel Cell Reactants	38	17		17
BURNOUT WEIGHT	8595	11000		11000
Main Propellant	31000	45000		45000
GROSS WEIGHT	39595	56000		56000

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POTENTIAL WEIGHT AND CENTER OF GRAVITY CHANGES

COMMAND MODULE

STRUCTURE	(+21)
Increase internal structure in area of the hatch to beam the hoop compression loads around the crew hatch.	+25
Increase heat shield substructure skin in area of crew hatch cover to distribute the compressive loads resulting from the cold soak condition.	+30
Increase due to revised estimate for installing and tying down the parachute bags.	+10
Decrease reaction control engine support panels to incorporate the revised engine installation concept.	-16
Decrease forward compartment gusset weight due to design weight reduction efforts.	-4
Increase X_c = 42 frame due to completion of structural load analysis and calculated versus estimated weight. The main contribution factor for this increase is designing for 78 g's in lieu of 35 g's.	+30
Increase the rendezvous and orientation window cover actuation and latching mechanisms due to redesign for the following reasons:	+20

(1) Cover weight increase plus increase in load criteria produced gear tooth loadings that were not acceptable.

(2) Remote actuation capability requested by Life Systems Group.

(3) Difference in thermal contraction between cover and ablator results in a cold soak condition wherein the cover deforms an estimated 0.40 inches. A "roller and ramp" type latch must be used in lieu of the simple friction latch currently employed.

Increase the astro-sextant door actuation and latching mechanisms in order to utilize differential gearing to increase efficiency and decrease gear tooth loading.	+3

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POTENTIAL WEIGHT AND CENTER OF GRAVITY CHANGES

COMMAND MODULE

STRUCTURE (CONTINUED)

The following changes, not effective on the first vehicles due to manufacturing schedules, will be realized on later effectivities:

(1) Revised latching concept allows basic skin gauge reduction to .008 inches on the rendezvous window cover (-23), crew hatch cover (-21) and heat shield area around the hatch (-30).	-74
(2) Revised umbilical installation substituting a honeycomb panel for a steel plate.	-3
COMMUNICATION AND INSTRUMENTATION	(+16)
Add electrical provisions for test instrumentation to monitor C-1 and C-5 booster.	+16
REACTION CONTROL SYSTEM	(+56)
Decrease RCS engines due to design change from 40:1 expansion ratio to 10:1 expansion ratio.	-19
Add engine inserts to be utilized as nozzle extensions. This item originally assumed to be in the Avco ablator, however, it is probable that it will be fabricated from 106 lb/ft^3 in lieu of Avcoat 5026-39 at 35 lb/ft^3 and will be obtained from a different subcontractor.	+40
Addition of Command Module reaction control propellant disposal system. This system is designed to dispose of the Command Module propellant prior to impact to eliminate potential explosion and/or fire.	+35
EARTH LANDING SYSTEM	(-105)
Increase parachute supports and attach structure to be compatible with increased structure loads imposed by the current ringsail parachutes.	+3
Decrease parachute weight consistent with incorporation of solid conical parachutes.	-105
Decrease parachute supports and attach structure due to reduced structure loads imposed by the proposed solid conical parachutes.	-3

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POTENTIAL WEIGHT AND CENTER OF GRAVITY CHANGES

COMMAND MODULE

SCIENTIFIC EQUIPMENT	(-200)
Decrease scientific equipment weight at launch based on NASA comments that this equipment will likely be located in the LEM.	-200
LEM INTEGRATION	(+220)
Modify structure to incorporate mating and locking capabilities and to strengthen hatch for mating impact loads.	+90
Add electrical provisions for power distribution and control for LEM system activation.	+20
Add in-flight test wiring for LEM checkout.	+25
Modify 2KMC OMNI antenna and relocate.	+28
Add rendezvous beacon radar installation as an aid during the rendezvous phase.	+25
Add cooling water for subsequent transfer to the LEM.	+32
TOTAL COMMAND MODULE POTENTIAL WEIGHT CHANGES	+8

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POTENTIAL WEIGHT AND CENTER OF GRAVITY CHANGES

SERVICE MODULE

STRUCTURE	(-64)
Delete insulation from the radial beams based on current Thermodynamics analysis.	-64
REACTION CONTROL SYSTEM	(+35)
Increase system for incorporation of provisions for RCS propellant quantity indication.	+35
ELECTRICAL POWER	(-42)
Revise the Supercritical Gas Storage System based on co-ordination with the subcontractor (Beech), to include the following changes:	-42

Internal Heaters	-3
Valve Modules	-7
Disconnects	-1
Insulation (H_2 System)	-20
Miscellaneous	+1
Pulsating Heaters in lieu of internal heaters	-12

MAIN PROPULSION	(+26)
Increase engine system due to nozzle change from an all titanium to a titanium - columbian combination - reflective heat problem.	+26
USEFUL LOAD	(-35)
Revise loading tolerance weight to reflect the volume of propellant required for the lunar mission.	-35
TOTAL POTENTIAL WEIGHT CHANGE - SERVICE MODULE	-80

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

SUMMARY

ITEM		CURRENT WEIGHT 4-1-63
WEIGHT EMPTY		7543
Structure	4173	
Crew Systems	512	
Communication & Instrumentation	797	
Guidance & Navigation	406	
Stabilization & Control	194	
Reaction Control	269	
Electrical Power	381	
Environmental Control	265	
Earth Landing	546	
USEFUL LOAD		1417
Crew Systems	752	
Reaction Control	258	
Environmental Control	157	
Scientific Payload	250	
GROSS WEIGHT		8960

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

STRUCTURE

ITEM	CURRENT WEIGHT 4-1-63
STRUCTURE	
Heat Shield	(1316)
Forward Compartment	180
Crew Compartment	677
Aft Compartment	459
Inner Structure	(942)
Forward Section	181
Forward Sidewall	358
Aft Sidewall	207
Aft Bulkhead	196
Secondary Structure	(469)
Ablation Material	(1260)
Microfiber Insulation	(186)
TOTAL STRUCTURE	4173

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

CREW SYSTEMS

ITEM	CURRENT WEIGHT 4-1-63
CREW SYSTEMS	
Personal Radiation Dosimeter (NASA)	5.0
Portable Life Support System (2) (NASA)	60.0
Personnel Communications (NASA)	5.0
Seat Liners & Restraint Harness	36.0
Sleeping Restraints	4.0
Waste Management	18.0
Lighting Equipment	15.0
Garments - Constant Wear (NASA)	9.0
Water Delivery Assy.	1.5
Survival Kit - Collective (1)	56.0
Shoe Straps (6 pr.)	2.0
Food Probe and Mouthpiece	4.0
Log Book, Pencils, etc.	1.0
Hatch Egress	3.0
Lap Board (2)	2.0
Manual - Maint. Maps, & Case	6.0
Suit Umbilical Hose (4)	10.0
In-Flight Test Maintenance Tool Belt	1.0
Structural Seats & Supports	258.0
Nuclear Radiation Detectors	7.0
In-Flight Maintenance Tool Set	1.0
Food Preparation Shelf	3.0
Personal Head Sets	4.5
TOTAL CREW SYSTEMS	512.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

COMMUNICATIONS & INSTRUMENTATION

ITEM	CURRENT WEIGHT 4-1-63
TELECOMMUNICATION	
Lower Bay	(249.5)
C-Band Transponder	20.3
Unified S-Band	25.0
S-Band Power Amplifier	20.5
VHF FM Transmitter/HF Transceiver	15.9
VHF AM Trans. -Rec./VHF Rec. Bea.	16.3
Multiplexer	12.0
Spares	19.0
PCM Telemetry Unit No. 1	22.5
PCM Telemetry Unit No. 2	17.5
Signal Conditioner	32.8
Recorder	22.0
Audio Center	7.7
Premodulation Processor	10.0
Central Timing Equipment	8.0
Remote Equipment	(140.5)
VHF/2-KMC OMNI Antenna & Transmission	56.0
HF Recovery Antenna & Transmission	15.0
C-Band Antenna & Transmission	16.0
VHF Recovery Antenna & Transmission	14.5
TV Camera	4.0
Instrumentation Sensors	35.0
Electrical Provisions	(96.0)
TOTAL TELECOMMUNICATIONS (to be brought forward)	486.0

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DETAIL WEIGHT STATEMENT
COMMAND MODULE
COMMUNICATION AND INSTRUMENTATION

ITEM	CURRENT WEIGHT 4-1-63
CONTROLS AND DISPLAYS	
Main Display Panel Control Station	(60.5)
Computer Data Insert & Display	15.0
Event Timer	.8
Mode Select	6.0
Delta Velocity	2.5
Flight Director Attitude Indicator	10.5
Gimbal Angle Indicator	2.0
Entry Monitoring Indicator	8.0
Launch Vehicle Emergency Detection System	6.0
Engine Gimbal Control	.7
Command Module Sequencer Control	.5
ELS Sequencer Control & Barometric Indicator	4.2
Launch Escape Control	.6
Crew Safety System	.9
Abort Light	.1
Caution Indicators	2.7
Main Display Panel Center Station	(27.9)
Audio Panel	1.3
8 Day Clock	.8
Abort Light	.1
CO_2 Warning Lights	.3
Reaction Control	6.7
Service Propulsion	8.6
Central Timing	.2
GMT Clock	.8
Thermal Profile	.5
ECS Liquid Control	2.8
ECS Gas Control	5.8
Main Display Panel System Management Station	(41.5)
Communications Control Panel	8.0
Antenna Control	3.0
Abort Light	.1
Caution Indicators	2.5
Power Distribution	11.0
Fuel Cells	8.6
Cryogenics	6.5
Event Timer	.8
Miscellaneous Telecommunication	1.0
Main Display Panel RH Console	(6.0)
Motor Control Switches	3.6
Audio Panel	1.3
Lighting Control	1.1
Main Display Panel LH Console	(4.1)
Sequencer Arming & Post Landing Control	.9
SCS Power Control	.8
Lighting Control	1.1
Audio Panel	1.3
[illegible]rical Provisions	(29.0)
Loudspeaker	(2.0)
TOTAL CONTROLS AND DISPLAYS (to be brought forward)	171.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

COMMUNICATION AND INSTRUMENTATION

ITEM	CURRENT WEIGHT 4-1-63
IN-FLIGHT TEST (RIGHT BAY FORWARD)	(125)
Crew Readout Panel	3
Manual Test Unit	15
Comparator	12
Programmer	11
Stimuli Generator	24
Panel Assy	15
Installation Provisions & Connectors	5
In-Flight Test - GSE Electrical Provisions	40
CREW AREA CONTROLS	(15)
Manual Control - Three Axis	7
Manual Control - Translation & Thrust	8
TOTAL IN-FLIGHT TEST & CREW AREA CONTROLS	140
TOTAL CONTROLS AND DISPLAYS	171
TOTAL TELECOMMUNICATION	486
TOTAL COMMUNICATIONS AND INSTRUMENTATION	797

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

GUIDANCE & NAVIGATION

ITEM	CURRENT WEIGHT 4-1-63
GUIDANCE & NAVIGATION	
Lower Equipment Bay	
Inertial Platform	58.3
Sextant	12.0
Telescope - Scanning	9.0
Map & Visual Display	8.5
Display & Control - Navigation	31.5
Display & Control - Computer	15.0
Navigation Base	24.0
Computer	58.0
Power Servo Assy	29.0
Coupling Display Unit	15.0
Junction Box	11.0
Cabling - MIT	40.0
Cabling - NAA	15.7
Spares	40.0
Optical Base	19.0
Eye Pieces	5.0
Bellows and Adapter	15.0
TOTAL GUIDANCE AND NAVIGATION	406.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

STABILIZATION AND CONTROL

ITEM	CURRENT WEIGHT 4-1-63
STABILIZATION AND CONTROL	
Lower Equipment Bay	(178.0)
Rate Gyro Package	6.5
Body Mounted Gyro Package	10.5
Electronic Control Package - Pitch	28.4
Electronic Control Package - Roll	29.1
Electronic Control Package - Yaw	28.4
Electronic Control Package - Auxiliary	30.5
Display/BMAG ECA Package	29.8
Spare Gyro - BMAG (2)	2.0
Spare Gyro - Rate	0.8
Spare Plug-in Module	12.0
Electrical Provisions	(16.0)
TOTAL STABILIZATION AND CONTROL	194.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

REACTION CONTROL SYSTEM

ITEM	CURRENT WEIGHT 4-1-63
REACTION CONTROL SYSTEM	
Propellant System	(74)
Tanks & Expulsion Devices	29
Plumbing, Fittings & Insulation	23
Valves & Regulators	21
Sensors	1
Pressure System	(57)
Tanks (4500 psi)	10
Plumbing, Fittings & Insulation	5
Valves & Regulators	39
Sensors	2
Helium	1
Engine System	(115)
Engines	115
Electrical Provisions	(23)
TOTAL REACTION CONTROL SYSTEM	269

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

ELECTRICAL POWER

ITEM	CURRENT WEIGHT 4-1-63
ELECTRICAL POWER	
Energy Source	(54.0)
Battery - Main (2)	36.0
Battery - Recovery (1)	18.0
Power Conversion	(110.0)
Inverter (3) & Control	105.0
Battery Charger & Controls	5.0
Power Distribution & Control	(150.0)
Power Distribution Equipment	
Circuit Breakers	6.0
Battery Controls	5.0
No. 1 and No. 2 AC Bus Control	15.0
DC Busses (Diodes, etc.)	10.0
AC Busses	5.0
Utility System Controls	15.0
Mounting Hardware	2.0
Sequencer	20.0
Right Hand Circuit Breaker Panel	13.0
Terminal Panels	5.0
Power Distribution Wiring & Provisions	40.0
Lighting Wiring & Provisions	5.0
Ground Power Provisions	6.0
Power Control Panel Connectors	3.0
Electrical - Common Utility	(67.0)
Utility Wiring and Circuit Components	20.0
Left Hand Circuit Breaker Panel	7.0
Umbilicals	23.5
Adapter Separation System	5.0
Launch Escape System Separation	3.5
Service Module Electrical Initiation	3.0
Installation Provisions	5.0
TOTAL ELECTRICAL POWER	381.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

ENVIRONMENTAL CONTROL SYSTEM

ITEM	CURRENT WEIGHT 4-1-63
ENVIRONMENTAL CONTROL SYSTEM	
Pressure Suit Circuit	(87.2)
Subcontractor Components	68.1
Ducting, Conn., Clamps, etc.	12.1
Gas Analyzer (NASA)	7.0
Water-Glycol Circuit	(49.4)
Subcontractor Components	27.4
Water-Glycol	18.4
Plumbing, etc.	3.6
Pressure & Temp. Control	(18.2)
Subcontractor Components	17.4
Ducting	0.8
Oxygen Supply System	(14.7)
Subcontractor Components	11.7
Plumbing	3.0
Water Supply System	(28.6)
Subcontractor Components	23.8
Plumbing	4.8
Subcontractor Common Items	(35.9)
Brackets, Plumbing, Elect. Wiring	11.3
Instrumentation	14.6
Radio Noise Filter Spec. Allowance	10.0
Supports	(10.0)
Electrical Provisions	(21.0)
TOTAL ENVIRONMENTAL CONTROL SYSTEM	265.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

EARTH LANDING SYSTEM

ITEM	CURRENT WEIGHT 4-1-63
EARTH LANDING SYSTEM	
Parachute System	(515.5)
Drogue Chute System	36.2
Drogue Disconnect Inst.	9.4
Main Cluster	412.5
Disconnect Main Cluster	9.7
Pilot Chute System	29.2
Sequence Control	13.5
Attach Provisions	5.0
Location Aids	(9.1)
Forward Heat Shield Release System	(16.0)
Electrical Pyrotechnic Initiation Provisions	(5.4)
TOTAL EARTH LANDING SYSTEM	546.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

USEFUL LOAD

ITEM	CURRENT WEIGHT 4-1-63
CREW SYSTEMS	(752)
Crew (3) (50, 70, 90, Percentile)	528
Pressure Garment Assy (3) (NASA)	90
Food	75
Food Containers	15
Personal Hygiene Equipment	23
Biomedical Instrumentation (NASA)	2
Medical Equipment	15
Chemical Disinfectant	4
REACTION CONTROL	(258)
RCS Propellant	258
ENVIRONMENTAL CONTROL	(157)
Lithium Hydroxide	112
Activated Charcoal	4
Containers for LiOH & Charcoal	6
Oxygen - Re-Entry	2
Water-Launch & Re-Entry Cooling	10
Freon	10
Water-Earth Orbit Cooling	4
Water - Drinking	4
Water - Mission Cooling	5
SCIENTIFIC PAYLOAD	(250)
TOTAL COMMAND MODULE USEFUL LOAD	1417

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

SUMMARY

ITEM		CURRENT WEIGHT 4-1-63
WEIGHT EMPTY		7574
Structure	2491	
Electronics	151	
Reaction Control	593	
Electrical Power	1190	
Environmental Control	78	
Propulsion	3071	
USEFUL LOAD		2246
Reaction Control	835	
Electrical Power	487	
Environmental Control	208	
Propulsion	716	
BURNOUT WEIGHT		9820
MAIN PROPELLANT - MAXIMUM USABLE CAPACITY		45000
GROSS WEIGHT		54820

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

STRUCTURE

ITEM	CURRENT WEIGHT 4-1-63
STRUCTURE	
Basic & Secondary Structure	
Radial Beams	436
Internal Structure & Engine Compartment Closeout	45
Outer Shell	920
Fairing - Command to Service	210
Engine Support	41
Antenna Support Structure	30
Forward Bulkhead Including Ring	155
Aft Bulkhead	370
Separation Provisions	20
Tank Support Shelf	30
Insulation	234
TOTAL STRUCTURE	2491

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

ELECTRONIC SUBSYSTEM

ITEM	CURRENT WEIGHT 4-1-63
ELECTRONICS SUBSYSTEM	
Communications	(72)
Antenna Dish	10
Antenna Gimbals	13
Antenna Deployment Booms	5
Antenna Coax Cabling	16
Antenna Coax Supports	3
Antenna Control Electrical Provisions	5
Antenna Locking Provisions	20
Instrumentation	(49)
Sensors	30
Electrical Provisions	14
Supports	5
In-Flight Test Provisions	(30)
In-Flight Test & GSE Electrical Provisions	30
TOTAL ELECTRONICS SUBSYSTEMS	151

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

REACTION CONTROL

ITEM	CURRENT WEIGHT 4-1-63
REACTION CONTROL SYSTEM	
Propellant System	(149)
Tanks & Expulsion Devices	58
Plumbing, Fittings & Insulation	17
Valves & Regulators	32
Sensors	6
Supports	36
Pressure System	(131)
Tanks (4500 psi)	19
Plumbing, Fittings & Insulation	6
Valves & Regulators	76
Sensors	7
Helium	3
Supports	20
Engine System	(175)
Engines	65
Reflectors & Insulation	110
Structural Provisions	(80)
Electrical Provisions	(58)
TOTAL REACTION CONTROL SYSTEM	593

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

ELECTRICAL POWER

ITEM	CURRENT WEIGHT 4-1-63
ELECTRICAL POWER	
Fuel Cell Power System	(1105.5)
Fuel Cell Power Pack (Incl. Mount & Instrumentation)	733.5
Intermodular - Radiator Plumbing	12.0
Fuel Cell Module Mount Attach.	2.0
Fuel Cell H_2 System	
Subcontractor Components	138.4
Plumbing and Valves	3.0
Fuel Cell and ECS O_2 System	
Subcontractor Components	165.2
Plumbing and Valves and Supports	22.0
Water Glycol - Fuel Cell Heat Transfer System	7.0
Elect. Wiring - Supercritical Gas	13.0
Space Radiator (Outer Skin)	9.4
Power Distribution	(50.5)
Relays & Diodes	10.0
Power Switch	5.4
Motor Switch	1.5
Umbilicals	14.4
Wiring & Busses	15.0
Supports	4.2
Electrical Utilities	(34.0)
Command - Service Separation System	5.0
Adapter Separation System	7.0
Electrical Initiation of Pyrotechnics	12.0
Supports	2.0
Sequencer	8.0
TOTAL ELECTRICAL POWER	1190.0

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

ENVIRONMENTAL CONTROL SYSTEM

ITEM	CURRENT WEIGHT 4-1-63
ENVIRONMENTAL CONTROL SYSTEM	
Water-Glycol Circuit	(43.6)
Subcontractor Components	8.5
Plumbing and Hardware	4.4
Radiator Provisions	5.6
Water - Glycol	3.4
Supports	4.7
Space Radiator (Outer Skin)	17.0
Water Supply System	(7.5)
Subcontractor Components	0.6
Plumbing and Hardware	6.0
Supports	0.9
Oxygen Supply System	(3.4)
Plumbing and Supports	3.0
Subcontractor Components	0.4
Subcontractor Common Supports	(0.5)
Electrical Provision	(23.0)
TOTAL ENVIRONMENTAL CONTROL SYSTEM	78.0

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

MAIN PROPULSION

ITEM	CURRENT WEIGHT 4-1-63
MAIN PROPULSION	
Propellant System	(1464)
Tanks & Integral Doors	990
Tank Skirts	209
Plumbing, Fittings & Insulation	95
Valves	9
Quantity Indication	70
Mixture Ratio Control	12
Supports - Plumbing & Equipment	79
Pressure System	(941)
Tanks (4500 psi)	800
Tank Supports	30
Plumbing, Fittings & Insulation	24
Valves, Regulators & Heat Exchanger	49
Supports - Plumbing & Equipment	38
Engine System	(640)
Engine	640
Electrical Provisions	(26)
TOTAL MAIN PROPULSION SYSTEM	3071

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

USEFUL LOAD

		CURRENT WEIGHT 4-1-63
REACTION CONTROL		(835.0)
Usable Reaction Control System Propellant		790.0
Unusable Reaction Control System Propellant		45.0
ELECTRICAL POWER (Normal Mission)		(487.0)
Hydrogen - Supercritical Gas		56.5
Usable (Electrochemical Incl. Tolerance)	44.0	
Unusable (Residual & Instrument Error)	3.2	
Emergency Provisions	4.7	
Expended (Leakage & Purge)	4.6	
Oxygen - Supercritical Gas		430.5
Usable (Electrochemical Incl. Tolerance)	363.0	
Unusable (Residual & Instrument Error)	17.5	
Emergency Provisions	44.0	
Expended (Leakage & Purge)	6.0	
ENVIRONMENTAL CONTROL (Normal Mission)		(208.0)
Oxygen - Supercritical Gas		208.0
Usable (Metabolic)	76.5	
Unusable (Residual & Instrument Error)	5.5	
Emergency Provisions	25.3	
Expended (Leakage, LEM, PLS, Re-Press.)	100.7	
PROPULSION		(716.0)
Main Propulsion Helium		99.0
Main Propellant Residuals		617.0
Trapped - System	225.0	
Trapped - Engine	67.0	
Mixture Ratio Tolerance	100.0	
Loading Tolerance	225.0	
Total Useful Load (Less Main Propellant)		2246.0

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DETAIL WEIGHT STATEMENT

LAUNCH ESCAPE SYSTEM

SUMMARY

ITEM	CURRENT WEIGHT 4-1-63
LAUNCH ESCAPE SYSTEM	
Structure	(968)
Tower Assy	269
Escape Motor Skirt	239
Jettison Motor Skirt	94
Pitch Motor Structure	157
Nose Cone and Ballast Support	110
Attaching Parts	28
Tower Insulation	45
Skirt Insulation	26
Ballast	(83)
Propulsion	(5259)
Escape Motor	4764
Jettison Motor	440
Pitch Control Motor	55
Electrical Power	(20)
TOTAL LAUNCH ESCAPE SYSTEM	6330

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DETAIL WEIGHT STATEMENT

ADAPTER

SUMMARY

ITEM	CURRENT WEIGHT 4-1-63
ADAPTER	
Structure	(2892)
Panels	1914
Frames	422
Thermal Insulation	556
Electrical Power	(76)
Separation System	(142)
TOTAL ADAPTER	3110